

SEQUENCE LISTING

<110> Hauer, Bernhard
 Schmid, Rolf D.
 Schwaneberg, Ulrich

<120> Electron donor system for enzymes and its use in the biochemical
 conversion of substrates

<130> M/40076

<140> US 10/031,241

<150> PCT/EP00/07251
 <151> 2000-07-27

<160> 35

<170> PatentIn Ver. 2.1

<210> 1
 <211> 36
 <212> DNA
 <213> Artificial sequence

<220>
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 Oligonucleotide for genomic Bacillus
 megaterium DNA

<400> 1
 gtgaaagagg gatcccatga caattaaaga aatgcc 36

<210> 2
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 Oligonucleotide for genomic Bacillus
 megaterium DNA

<400> 2
 gcctcttgga tccttaccca gccacacgt cttttgcg 38

<210> 3
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<400> 3
 gtacgtgatt ttgcaggag

<210> 4
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sequencing

<400> 4
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<220>
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cccagcttat gatgaaaac 19

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<400> 7
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<210> 8
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<400> 8
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<400> 12
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<400> 13
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<400> 22
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<400> 23
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<210> 24

2047044-0440

<211> 36
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 Oligonucleotide for tag at C terminus

<400> 24
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<400> 25
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 Oligonucleotide for tag at C terminus

<400> 28
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<400> 29
 cgcaattctt aatgatgatg atgatgatgc ccagcccaca cg 42

<210> 30
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<400> 30
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<210> 31
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<400> 31
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<211> 34
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 <213> Artificial sequence

<220>

<223> Description of the artificial sequence: Primer for
 P450 BM-3 point mutant F87A

<400> 32
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<210> 33
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 <212> DNA
 <213> Artificial sequence

<220>

<223> Description of the artificial sequence: Primer for
 P450 BM-3 point mutant F87A

<400> 33
 catgcgtcca gcttgaggcc aaccgctctc ctgc 34

<210> 34
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 <212> DNA
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<220>

<221> CDS
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<400> 34
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 Thr Ile Lys Glu Met Pro Gln Pro Lys Thr Phe Gly Glu Leu Lys
 1 5 10 15
 aat tta ccg tta tta aac aca gat aaa ccg gtt caa gct ttg atg aaa 96
 Asn Leu Pro Leu Leu Asn Thr Asp Lys Pro Val Gln Ala Leu Met Lys
 20 25 30
 att gcg gat gaa tta gga gaa atc ttt aaa ttc gag gcg cct ggt cgt 144
 Ile Ala Asp Glu Leu Gly Glu Ile Phe Lys Phe Glu Ala Pro Gly Arg
 35 40 45
 gta acg cgc tac tta tca agt cag cgt cta att aaa gaa gca tgc gat 192
 Val Thr Arg Tyr Leu Ser Ser Gln Arg Leu Ile Lys Glu Ala Cys Asp
 50 55 60
 gaa tca cgc ttt gat aaa aac tta agt caa gcg ctt aaa ttt gta cgt 240
 Glu Ser Arg Phe Asp Lys Asn Leu Ser Gln Ala Leu Lys Phe Val Arg

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| 65 | 70 | 75 | |
|---|-----|-----|-----|
| gat ttt gca gga gac ggg tta ttt aca agc tgg acg cat gaa aaa aat | | | 288 |
| Asp Phe Ala Gly Asp Gly Leu Phe Thr Ser Trp Thr His Glu Lys Asn | | | |
| 80 | 85 | 90 | 95 |
| tgg aaa aaa gcg cat aat atc tta ctt cca agc ttc agt cag cag gca | | | 336 |
| Trp Lys Lys Ala His Asn Ile Leu Leu Pro Ser Phe Ser Gln Gln Ala | | | |
| | 100 | 105 | 110 |
| atg aaa ggc tat cat gcg atg atg gtc gat atc gcc gtg cag ctt gtt | | | 384 |
| Met Lys Gly Tyr His Ala Met Met Val Asp Ile Ala Val Gln Leu Val | | | |
| | 115 | 120 | 125 |
| caa aag tgg gag cgt cta aat gca gat gag cat att gaa gta ccg gaa | | | 432 |
| Gln Lys Trp Glu Arg Leu Asn Ala Asp Glu His Ile Glu Val Pro Glu | | | |
| | 130 | 135 | 140 |
| gac atg aca cgt tta acg ctt gat aca att ggt ctt tgc ggc ttt aac | | | 480 |
| Asp Met Thr Arg Leu Thr Leu Asp Thr Ile Gly Leu Cys Gly Phe Asn | | | |
| | 145 | 150 | 155 |
| tat cgc ttt aac agc ttt tac cga gat cag cct cat cca ttt att aca | | | 528 |
| Tyr Arg Phe Asn Ser Phe Tyr Arg Asp Gln Pro His Pro Phe Ile Thr | | | |
| | 160 | 165 | 170 |
| agt atg gtc cgt gca ctg gat gaa gca atg aac aag ctg cag cga gca | | | 576 |
| Ser Met Val Arg Ala Leu Asp Glu Ala Met Asn Lys Leu Gln Arg Ala | | | |
| | 180 | 185 | 190 |
| aat cca gac gac cca gct tat gat gaa aac aag cgc cag ttt caa gaa | | | 624 |
| Asn Pro Asp Asp Pro Ala Tyr Asp Glu Asn Lys Arg Gln Phe Gln Glu | | | |
| | 195 | 200 | 205 |
| gat atc aag gtg atg aac gac cta gta gat aaa att att gca gat cgc | | | 672 |
| Asp Ile Lys Val Met Asn Asp Leu Val Asp Lys Ile Ile Ala Asp Arg | | | |
| | 210 | 215 | 220 |
| aaa gca agc ggt gaa caa agc gat gat tta tta acg cat atg cta aac | | | 720 |
| Lys Ala Ser Gly Glu Gln Ser Asp Asp Leu Leu Thr His Met Leu Asn | | | |
| | 225 | 230 | 235 |
| gga aaa gat cca gaa acg ggt gag ccg ctt gat gac gag aac att cgc | | | 768 |
| Gly Lys Asp Pro Glu Thr Gly Glu Pro Leu Asp Asp Glu Asn Ile Arg | | | |
| | 240 | 245 | 250 |
| tat caa att att aca ttc tta att gcg gga cac gaa aca aca agt ggt | | | 816 |
| Tyr Gln Ile Ile Thr Phe Leu Ile Ala Gly His Glu Thr Thr Ser Gly | | | |
| | 260 | 265 | 270 |
| ctt tta tca ttt gcg ctg tat ttc tta gtg aaa aat cca cat gta tta | | | 864 |
| Leu Leu Ser Phe Ala Leu Tyr Phe Leu Val Lys Asn Pro His Val Leu | | | |

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| 275 | 280 | 285 | |
|---|-----|-----|------|
| caa aaa gca gca gaa gaa gca gca cga gtt cta gta gat cct gtt cca | | | 912 |
| Gln Lys Ala Ala Glu Glu Ala Ala Arg Val Leu Val Asp Pro Val Pro | | | |
| 290 | 295 | 300 | |
| agc tac aaa caa gtc aaa cag ctt aaa tat gtc ggc atg gtc tta aac | | | 960 |
| Ser Tyr Lys Gln Val Lys Gln Leu Lys Tyr Val Gly Met Val Leu Asn | | | |
| 305 | 310 | 315 | |
| gaa gcg ctg cgc tta tgg cca act gct cct gcg ttt tcc cta tat gca | | | 1008 |
| Glu Ala Leu Arg Leu Trp Pro Thr Ala Pro Ala Phe Ser Leu Tyr Ala | | | |
| 320 | 325 | 330 | 335 |
| aaa gaa gat acg gtg ctt gga gga gaa tat cct tta gaa aaa ggc gac | | | 1056 |
| Lys Glu Asp Thr Val Leu Gly Gly Glu Tyr Pro Leu Glu Lys Gly Asp | | | |
| 340 | 345 | 350 | |
| gaa cta atg gtt ctg att cct cag ctt cac cgt gat aaa aca att tgg | | | 1104 |
| Glu Leu Met Val Leu Ile Pro Gln Leu His Arg Asp Lys Thr Ile Trp | | | |
| 355 | 360 | 365 | |
| gga gac gat gtg gaa gag ttc cgt cca gag cgt ttt gaa aat cca agt | | | 1152 |
| Gly Asp Asp Val Glu Glu Phe Arg Pro Glu Arg Phe Glu Asn Pro Ser | | | |
| 370 | 375 | 380 | |
| gcg att ccg cag cat gcg ttt aaa ccg ttt gga aac ggt cag cgt gcg | | | 1200 |
| Ala Ile Pro Gln His Ala Phe Lys Pro Phe Gly Asn Gly Gln Arg Ala | | | |
| 385 | 390 | 395 | |
| tgt atc ggt cag cag ttc gct ctt cat gaa gca acg ctg gta ctt ggt | | | 1248 |
| Cys Ile Gly Gln Gln Phe Ala Leu His Glu Ala Thr Leu Val Leu Gly | | | |
| 400 | 405 | 410 | 415 |
| atg atg cta aaa cac ttt gac ttt gaa gat cat aca aac tac gag ctg | | | 1296 |
| Met Met Leu Lys His Phe Asp Phe Glu Asp His Thr Asn Tyr Glu Leu | | | |
| 420 | 425 | 430 | |
| gat att aaa gaa act tta acg tta aaa cct gaa ggc ttt gtg gta aaa | | | 1344 |
| Asp Ile Lys Glu Thr Leu Thr Leu Lys Pro Glu Gly Phe Val Val Lys | | | |
| 435 | 440 | 445 | |
| gca aaa tcg aaa aaa att ccg ctt ggc ggt att cct tca cct agc act | | | 1392 |
| Ala Lys Ser Lys Lys Ile Pro Leu Gly Gly Ile Pro Ser Pro Ser Thr | | | |
| 450 | 455 | 460 | |
| gaa cag tct gct aaa aaa gta cgc aaa aag gca gaa aac gct cat aat | | | 1440 |
| Glu Gln Ser Ala Lys Lys Val Arg Lys Lys Ala Glu Asn Ala His Asn | | | |
| 465 | 470 | 475 | |
| acg ccg ctg ctt gtg cta tac ggt tca aat atg gga aca gct gaa gga | | | 1488 |
| Thr Pro Leu Leu Val Leu Tyr Gly Ser Asn Met Gly Thr Ala Glu Gly | | | |

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| | | | | | | | | | | | | | | | | | | | | | |
|---|------|--|--|--|--|--|--|--|-----|--|--|--|--|--|--|--|-----|--|--|--|--|
| 480 | 485 | | | | | | | | 490 | | | | | | | | 495 | | | | |
| acg gcg cgt gat tta gca gat att gca atg agc aaa gga ttt gca ccg | 1536 | | | | | | | | | | | | | | | | | | | | |
| Thr Ala Arg Asp Leu Ala Asp Ile Ala Met Ser Lys Gly Phe Ala Pro | | | | | | | | | | | | | | | | | | | | | |
| 500 505 510 | | | | | | | | | | | | | | | | | | | | | |
| cag gtc gca acg ctt gat tca cac gcc gga aat ctt ccg cgc gaa gga | 1584 | | | | | | | | | | | | | | | | | | | | |
| Gln Val Ala Thr Leu Asp Ser His Ala Gly Asn Leu Pro Arg Glu Gly | | | | | | | | | | | | | | | | | | | | | |
| 515 520 525 | | | | | | | | | | | | | | | | | | | | | |
| gct gta tta att gta acg gcg tct tat aac ggt cat ccg cct gat aac | 1632 | | | | | | | | | | | | | | | | | | | | |
| Ala Val Leu Ile Val Thr Ala Ser Tyr Asn Gly His Pro Pro Asp Asn | | | | | | | | | | | | | | | | | | | | | |
| 530 535 540 | | | | | | | | | | | | | | | | | | | | | |
| gca aag caa ttt gtc gac tgg tta gac caa gcg tct gct gat gaa gta | 1680 | | | | | | | | | | | | | | | | | | | | |
| Ala Lys Gln Phe Val Asp Trp Leu Asp Gln Ala Ser Ala Asp Glu Val | | | | | | | | | | | | | | | | | | | | | |
| 545 550 555 | | | | | | | | | | | | | | | | | | | | | |
| aaa ggc gtt cgc tac tcc gta ttt gga tgc gcc gat aaa aac tgg gct | 1728 | | | | | | | | | | | | | | | | | | | | |
| Lys Gly Val Arg Tyr Ser Val Phe Gly Cys Gly Asp Lys Asn Trp Ala | | | | | | | | | | | | | | | | | | | | | |
| 560 565 570 575 | | | | | | | | | | | | | | | | | | | | | |
| act acg tat caa aaa gtg cct gct ttt atc gat gaa acg ctt gcc gct | 1776 | | | | | | | | | | | | | | | | | | | | |
| Thr Thr Tyr Gln Lys Val Pro Ala Phe Ile Asp Glu Thr Leu Ala Ala | | | | | | | | | | | | | | | | | | | | | |
| 580 585 590 | | | | | | | | | | | | | | | | | | | | | |
| aaa ggg gca gaa aac atc gct gac cgc ggt gaa gca gat gca agc gac | 1824 | | | | | | | | | | | | | | | | | | | | |
| Lys Gly Ala Glu Asn Ile Ala Asp Arg Gly Glu Ala Asp Ala Ser Asp | | | | | | | | | | | | | | | | | | | | | |
| 595 600 605 | | | | | | | | | | | | | | | | | | | | | |
| gac ttt gaa ggc aca tat gaa gaa tgg cgt gaa cat atg tgg agt gac | 1872 | | | | | | | | | | | | | | | | | | | | |
| Asp Phe Glu Gly Thr Tyr Glu Glu Trp Arg Glu His Met Trp Ser Asp | | | | | | | | | | | | | | | | | | | | | |
| 610 615 620 | | | | | | | | | | | | | | | | | | | | | |
| gta gca gcc tac ttt aac ctc gac att gaa aac agt gaa gat aat aaa | 1920 | | | | | | | | | | | | | | | | | | | | |
| Val Ala Ala Tyr Phe Asn Leu Asp Ile Glu Asn Ser Glu Asp Asn Lys | | | | | | | | | | | | | | | | | | | | | |
| 625 630 635 | | | | | | | | | | | | | | | | | | | | | |
| tct act ctt tca ctt caa ttt gtc gac agc gcc gcg gat atg ccg ctt | 1968 | | | | | | | | | | | | | | | | | | | | |
| Ser Thr Leu Ser Leu Gln Phe Val Asp Ser Ala Ala Asp Met Pro Leu | | | | | | | | | | | | | | | | | | | | | |
| 640 645 650 655 | | | | | | | | | | | | | | | | | | | | | |
| gcg aaa atg cac ggt gcg ttt tca acg aac gtc gta gca agc aaa gaa | 2016 | | | | | | | | | | | | | | | | | | | | |
| Ala Lys Met His Gly Ala Phe Ser Thr Asn Val Val Ala Ser Lys Glu | | | | | | | | | | | | | | | | | | | | | |
| 660 665 670 | | | | | | | | | | | | | | | | | | | | | |
| ctt caa cag cca ggc agt gca cga agc acg cga cat ctt gaa att gaa | 2064 | | | | | | | | | | | | | | | | | | | | |
| Leu Gln Gln Pro Gly Ser Ala Arg Ser Thr Arg His Leu Glu Ile Glu | | | | | | | | | | | | | | | | | | | | | |
| 675 680 685 | | | | | | | | | | | | | | | | | | | | | |
| ctt cca aaa gaa gct tct tat caa gaa gga gat cat tta ggt gtt att | 2112 | | | | | | | | | | | | | | | | | | | | |
| Leu Pro Lys Glu Ala Ser Tyr Gln Glu Gly Asp His Leu Gly Val Ile | | | | | | | | | | | | | | | | | | | | | |

| 690 | 695 | 700 | |
|---|-----|-----|------|
| cct cgc aac tat gaa gga ata gta aac cgt gta aca gca agg ttc ggc | | | 2160 |
| Pro Arg Asn Tyr Glu Gly Ile Val Asn Arg Val Thr Ala Arg Phe Gly | | | |
| 705 | 710 | 715 | |
| cta gat gca tca cag caa atc cgt ctg gaa gca gaa gaa gaa aaa tta | | | 2208 |
| Leu Asp Ala Ser Gln Gln Ile Arg Leu Glu Ala Glu Glu Glu Lys Leu | | | |
| 720 | 725 | 730 | 735 |
| gct cat ttg cca ctc gct aaa aca gta tcc gta gaa gag ctt ctg caa | | | 2256 |
| Ala His Leu Pro Leu Ala Lys Thr Val Ser Val Glu Glu Leu Leu Gln | | | |
| 740 | 745 | 750 | |
| tac gtg gag ctt caa gat cct gtt acg cgc acg cag ctt cgc gca atg | | | 2304 |
| Tyr Val Glu Leu Gln Asp Pro Val Thr Arg Thr Gln Leu Arg Ala Met | | | |
| 755 | 760 | 765 | |
| gct gct aaa acg gtc tgc ccg ccg cat aaa gta gag ctt gaa gcc ttg | | | 2352 |
| Ala Ala Lys Thr Val Cys Pro Pro His Lys Val Glu Leu Glu Ala Leu | | | |
| 770 | 775 | 780 | |
| ctt gaa aag caa gcc tac aaa gaa caa gtg ctg gca aaa cgt tta aca | | | 2400 |
| Leu Glu Lys Gln Ala Tyr Lys Glu Gln Val Leu Ala Lys Arg Leu Thr | | | |
| 785 | 790 | 795 | |
| atg ctt gaa ctg ctt gaa aaa tac ccg gcg tgt gaa atg aaa ttc agc | | | 2448 |
| Met Leu Glu Leu Leu Glu Lys Tyr Pro Ala Cys Glu Met Lys Phe Ser | | | |
| 800 | 805 | 810 | 815 |
| gaa ttt atc gcc ctt ctg cca agc ata cgc ccg cgc tat tac tcg att | | | 2496 |
| Glu Phe Ile Ala Leu Leu Pro Ser Ile Arg Pro Arg Tyr Tyr Ser Ile | | | |
| 820 | 825 | 830 | |
| tct tca tca cct cgt gtc gat gaa aaa caa gca agc atc acg gtc agc | | | 2544 |
| Ser Ser Ser Pro Arg Val Asp Glu Lys Gln Ala Ser Ile Thr Val Ser | | | |
| 835 | 840 | 845 | |
| gtt gtc tca gga gaa gcg tgg agc gga tat gga gaa tat aaa gga att | | | 2592 |
| Val Val Ser Gly Glu Ala Trp Ser Gly Tyr Gly Glu Tyr Lys Gly Ile | | | |
| 850 | 855 | 860 | |
| gcg tcg aac tat ctt gcc gag ctg caa gaa gga gat acg att acg tgc | | | 2640 |
| Ala Ser Asn Tyr Leu Ala Glu Leu Gln Glu Gly Asp Thr Ile Thr Cys | | | |
| 865 | 870 | 875 | |
| ttt att tcc aca ccg cag tca gaa ttt acg ctg cca aaa gac cct gaa | | | 2688 |
| Phe Ile Ser Thr Pro Gln Ser Glu Phe Thr Leu Pro Lys Asp Pro Glu | | | |
| 880 | 885 | 890 | 895 |
| acg ccg ctt atc atg gtc gga ccg gga aca ggc gtc gcg ccg ttt aga | | | 2736 |
| Thr Pro Leu Ile Met Val Gly Pro Gly Thr Gly Val Ala Pro Phe Arg | | | |

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| 900 | 905 | 910 | |
|---|-----------------------------|------|--|
| ggc ttt gtg cag gcg cgc aaa cag cta | aaa gaa caa gga cag tca ctt | 2784 | |
| Gly Phe Val Gln Ala Arg Lys Gln Leu | Lys Glu Gln Gly Gln Ser Leu | | |
| 915 | 920 | 925 | |
| gga gaa gca cat tta tac ttc ggc tgc cgt tca cct cat gaa gac tat | 2832 | | |
| Gly Glu Ala His Leu Tyr Phe Gly Cys Arg Ser Pro His Glu Asp Tyr | | | |
| 930 | 935 | 940 | |
| ctg tat caa gaa gag ctt gaa aac gcc caa agc gaa ggc atc att acg | 2880 | | |
| Leu Tyr Gln Glu Glu Leu Glu Asn Ala Gln Ser Glu Gly Ile Ile Thr | | | |
| 945 | 950 | 955 | |
| ctt cat acc gct ttt tct cgc atg cca aat cag ccg aaa aca tac gtt | 2928 | | |
| Leu His Thr Ala Phe Ser Arg Met Pro Asn Gln Pro Lys Thr Tyr Val | | | |
| 960 | 965 | 970 | |
| cag cac gta atg gaa caa gac ggc aag aaa ttg att gaa ctt ctt gat | 2976 | | |
| Gln His Val Met Glu Gln Asp Gly Lys Lys Leu Ile Glu Leu Leu Asp | | | |
| 980 | 985 | 990 | |
| caa gga gcg cac ttc tat att tgc gga gac gga agc caa atg gca cct | 3024 | | |
| Gln Gly Ala His Phe Tyr Ile Cys Gly Asp Gly Ser Gln Met Ala Pro | | | |
| 995 | 1000 | 1005 | |
| gcc gtt gaa gca acg ctt atg aaa agc tat gct gac gtt cac caa gtg | 3072 | | |
| Ala Val Glu Ala Thr Leu Met Lys Ser Tyr Ala Asp Val His Gln Val | | | |
| 1010 | 1015 | 1020 | |
| agt gaa gca gac gct cgc tta tgg ctg cag cag cta gaa gaa aaa ggc | 3120 | | |
| Ser Glu Ala Asp Ala Arg Leu Trp Leu Gln Gln Leu Glu Glu Lys Gly | | | |
| 1025 | 1030 | 1035 | |
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| Arg Tyr Ala Lys Asp Val Trp Ala Gly | | | |
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<400> 35

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| Thr | Ile | Lys | Glu | Met | Pro | Gln | Pro | Lys | Thr | Phe | Gly | Glu | Leu | Lys | Asn |
| 1 | | | | 5 | | | | | 10 | | | | | 15 | |

| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Leu | Pro | Leu | Leu | Asn | Thr | Asp | Lys | Pro | Val | Gln | Ala | Leu | Met | Lys | Ile |
| | | | | 20 | | | | 25 | | | | | | 30 | |

Ala Asp Glu Leu Gly Glu Ile Phe Lys Phe Glu Ala Pro Gly Arg Val

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| 35 | | | | | 40 | | | | | 45 | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
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| Ser | Arg | Phe | Asp | Lys | Asn | Leu | Ser | Gln | Ala | Leu | Lys | Phe | Val | Arg | Asp |
| 65 | | | | | 70 | | | | | 75 | | | | | 80 |
| Phe | Ala | Gly | Asp | Gly | Leu | Phe | Thr | Ser | Trp | Thr | His | Glu | Lys | Asn | Trp |
| | | | | 85 | | | | | 90 | | | | | 95 | |
| Lys | Lys | Ala | His | Asn | Ile | Leu | Leu | Pro | Ser | Phe | Ser | Gln | Gln | Ala | Met |
| | | | 100 | | | | | 105 | | | | | 110 | | |
| Lys | Gly | Tyr | His | Ala | Met | Met | Val | Asp | Ile | Ala | Val | Gln | Leu | Val | Gln |
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| Met | Thr | Arg | Leu | Thr | Leu | Asp | Thr | Ile | Gly | Leu | Cys | Gly | Phe | Asn | Tyr |
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| Arg | Phe | Asn | Ser | Phe | Tyr | Arg | Asp | Gln | Pro | His | Pro | Phe | Ile | Thr | Ser |
| | | | | 165 | | | | | 170 | | | | | 175 | |
| Met | Val | Arg | Ala | Leu | Asp | Glu | Ala | Met | Asn | Lys | Leu | Gln | Arg | Ala | Asn |
| | | | 180 | | | | | 185 | | | | | 190 | | |
| Pro | Asp | Asp | Pro | Ala | Tyr | Asp | Glu | Asn | Lys | Arg | Gln | Phe | Gln | Glu | Asp |
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| Ile | Lys | Val | Met | Asn | Asp | Leu | Val | Asp | Lys | Ile | Ile | Ala | Asp | Arg | Lys |
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| Lys | Asp | Pro | Glu | Thr | Gly | Glu | Pro | Leu | Asp | Asp | Glu | Asn | Ile | Arg | Tyr |
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| Gln | Ile | Ile | Thr | Phe | Leu | Ile | Ala | Gly | His | Glu | Thr | Thr | Ser | Gly | Leu |
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| Leu | Ser | Phe | Ala | Leu | Tyr | Phe | Leu | Val | Lys | Asn | Pro | His | Val | Leu | Gln |
| | | | 275 | | | | 280 | | | | | 285 | | | |
| Lys | Ala | Ala | Glu | Glu | Ala | Ala | Arg | Val | Leu | Val | Asp | Pro | Val | Pro | Ser |
| | 290 | | | | | 295 | | | | | 300 | | | | |
| Tyr | Lys | Gln | Val | Lys | Gln | Leu | Lys | Tyr | Val | Gly | Met | Val | Leu | Asn | Glu |
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| | | | | | | | | | | | | | | | |
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| Lys | Ser | Lys | Lys | Ile | Pro | Leu | Gly | Gly | Ile | Pro | Ser | Pro | Ser | Thr | Glu |
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| Gly | Val | Arg | Tyr | Ser | Val | Phe | Gly | Cys | Gly | Asp | Lys | Asn | Trp | Ala | Thr |
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